
Appendix B - ATmega88 Automotive Specification at 1.8V

This document contains information specific to devices operating at voltage between 1.8V and 5.5V. Only deviations with standard operating characteristics are covered in this appendix, all other information can be found in the complete Automotive datasheet. The complete ATmega88 automotive datasheet can be found on www.atmel.com



**8-bit AVR[®]
Microcontroller
with 8K Bytes
In-System
Programmable
Flash**

**ATmega88
Automotive**

Appendix B

7738C-AVR-11/09



1. Electrical Characteristics

1.1 Absolute Maximum Ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Parameters	Test Conditions	Unit
Operating Temperature	-55 to +150	°C
Storage Temperature	-65 to +175	°C
Voltage on any Pin except $\overline{\text{RESET}}$ with respect to Ground	-0.5 to $V_{CC}+0.5$	V
Voltage on $\overline{\text{RESET}}$ with respect to Ground	-0.5 to +13.0	V
Maximum Operating Voltage	6.0	V
DC Current per I/O Pin	30	mA
DC Current V_{CC} and GND	200.0	

1.2 DC Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = 1.8\text{V}$ to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Input Low Voltage, except XTAL1 and $\overline{\text{RESET}}$ pin	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IL}	-0.5		$0.1V_{CC}^{(1)}$	V
Input High Voltage, except XTAL1 and $\overline{\text{RESET}}$ pins	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IH}	$0.75V_{CC}^{(2)}$		$V_{CC} + 0.5$	V
Input Low Voltage, XTAL1 pin	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IL1}	-0.5		$+0.1V_{CC}^{(1)}$	V
Input High Voltage, XTAL1 pin	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IH1}	$0.9V_{CC}^{(2)}$		$V_{CC} + 0.5$	V
Input Low Voltage, $\overline{\text{RESET}}$ pin	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IL2}	-0.5		$+0.1V_{CC}^{(1)}$	V
Input High Voltage, $\overline{\text{RESET}}$ pin	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IH2}	$0.9V_{CC}^{(2)}$		$V_{CC} + 0.5$	V
Input Low Voltage, $\overline{\text{RESET}}$ pin as I/O	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IL3}	-0.5		$+0.1V_{CC}^{(1)}$	V
Input High Voltage, $\overline{\text{RESET}}$ pin as I/O	$V_{CC} = 1.8\text{V}$ to 5.5V	V_{IH3}	$0.6V_{CC}^{(2)}$		$0.7V_{CC}$	V

- Notes:
- “Max” means the highest value where the pin is guaranteed to be read as low
 - “Min” means the lowest value where the pin is guaranteed to be read as high
 - Although each I/O port can sink more than the test conditions (0.5 mA at $V_{CC} = 1.8\text{V}$) under steady state conditions (non-transient), the following must be observed:
 - The sum of all IOL, for ports B0 - B5, should not exceed 50 mA.
If IOL exceeds the test condition, VOL may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
 - Although each I/O port can source more than the test conditions (0.5 mA at $V_{CC} = 1.8\text{V}$) under steady state conditions (non-transient), the following must be observed:
 - The sum of all IOH, for ports B0 - B5 should not exceed 50 mA.
If IOH exceeds the test condition, VOH may exceed the related specification. Pins are not guaranteed to source current greater than the listed test condition.
 - Minimum V_{CC} for Power-down is 2.5V.

1.2 DC Characteristics (Continued)

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, $V_{CC} = 1.8\text{V}$ to 5.5V (unless otherwise noted) (Continued)

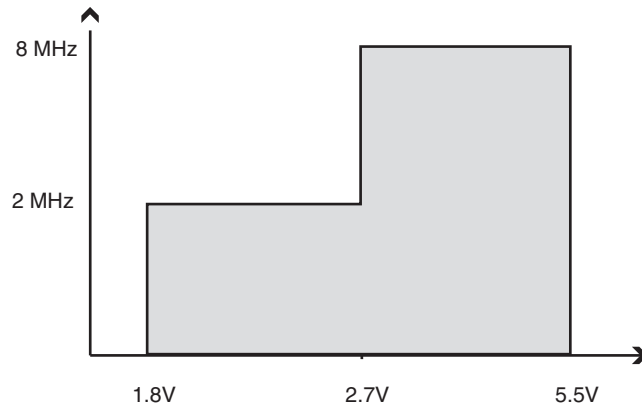
Parameters	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Output Low Voltage ⁽³⁾ , I/O pin except RESET	$I_{OL} = 0.5\text{ mA}$, $V_{CC} = 1.8\text{V}$	V_{OL}			0.25	V
Output High Voltage ⁽⁴⁾ , I/O pin except RESET	$I_{OH} = -0.5\text{ mA}$, $V_{CC} = 1.8\text{V}$	V_{OH}	1.25			V
Input Leakage Current I/O Pin	$V_{CC} = 5.5\text{V}$, pin low (absolute value)	I_{IL}			1	μA
Input Leakage Current I/O Pin	$V_{CC} = 5.5\text{V}$, pin high (absolute value)	I_{IH}			1	μA
Reset Pull-up Resistor		R_{RST}	30		60	$\text{k}\Omega$
I/O Pin Pull-up Resistor		R_{PU}	20		50	$\text{k}\Omega$
Power Supply Current ⁽⁵⁾	Active 2 MHz, $V_{CC} = 1.8\text{V}$	I_{CC}		0.8	1.2	mA
	Idle 2 MHz, $V_{CC} = 1.8\text{V}$			0.2	0.4	mA
Power-down mode	WDT disabled, $V_{CC} = 1.8\text{V}$ WDT enabled, $V_{CC} = 1.8\text{V}$			0.2 4	18 24	μA
Analog Comparator Input Offset Voltage	$V_{CC} = 2.7\text{V}$ $V_{in} = V_{CC}/2$	V_{ACIO}		<10	40	mV
Analog Comparator Input Leakage Current	$V_{CC} = 2.7\text{V}$ $V_{in} = V_{CC}/2$	I_{ACLK}	-50		+50	nA
Analog Comparator Propagation Delay	$V_{CC} = 2.7\text{V}$	t_{ACPD}		500		ns

- Notes:
1. "Max" means the highest value where the pin is guaranteed to be read as low
 2. "Min" means the lowest value where the pin is guaranteed to be read as high
 3. Although each I/O port can sink more than the test conditions (0.5 mA at $V_{CC} = 1.8\text{V}$) under steady state conditions (non-transient), the following must be observed:
 - 1] The sum of all I_{OL} , for ports B0 - B5, should not exceed 50 mA.
If I_{OL} exceeds the test condition, V_{OL} may exceed the related specification. Pins are not guaranteed to sink current greater than the listed test condition.
 4. Although each I/O port can source more than the test conditions (0.5 mA at $V_{CC} = 1.8\text{V}$) under steady state conditions (non-transient), the following must be observed:
 - 1] The sum of all I_{OH} , for ports B0 - B5 should not exceed 50 mA.
If I_{OH} exceeds the test condition, V_{OH} may exceed the related specification. Pins are not guaranteed to source current greater than the listed test condition.
 5. Minimum V_{CC} for Power-down is 2.5V.

1.3 Maximum Speed versus V_{CC}

Maximum frequency is dependent on V_{CC} .

Figure 1-1. Maximum Frequency versus V_{CC}



1.4 ADC Characteristics

$T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$, $V_{CC} = 1.8\text{V}$ to 5.5V (unless otherwise noted)

Parameters	Test Conditions	Symbol	Min	Typ	Max	Unit
Resolution	-40°C to $+85^\circ\text{C}$ - 1.8V to 2.7V ADC clock = 125 kHz			10		Bits
	-40°C to $+85^\circ\text{C}$ - 2.7V to 5.5V ADC clock = 200 kHz			10		Bits
Absolute accuracy	$V_{CC} = 1.8\text{V}$, $V_{Ref} = 1.8\text{V}$	TUE		2.2	3.5	LSB
	$V_{CC} = 4.0\text{V}$, $V_{Ref} = 4.0\text{V}$			2.1	3.5	LSB
Integral Non Linearity	$V_{CC} = 1.8\text{V}$, $V_{Ref} = 1.8\text{V}$	INL		0.6	2.0	LSB
	$V_{CC} = 4.0\text{V}$, $V_{Ref} = 4.0\text{V}$			0.5	1.5	LSB
Differential Non Linearity	$V_{CC} = 1.8\text{V}$, $V_{Ref} = 1.8\text{V}$	DNL		0.4	1.0	LSB
	$V_{CC} = 4.0\text{V}$, $V_{Ref} = 4.0\text{V}$			0.3	0.7	LSB
Gain error			-3.5	-1.5	3.5	LSB
Offset error			-3.5	2.0	3.5	LSB
Clock frequency	$V_{CC} = 1.8\text{V}$ to 2.7V		50		125	kHz
	$V_{CC} = 2.7\text{V}$ to 5.5V		50		200	kHz
Analog Supply Voltage		AV_{CC}	$V_{CC} - 0.3$		$V_{CC} + 0.3$	V
Reference Voltage		V_{REF}	1.0		AV_{CC}	V
Input Voltage		V_{IN}	GND		$V_{REF} - 50\text{mV}$	V
Input Bandwidth				38.5		kHz
Internal Voltage Reference		V_{INT}	1.0	1.1	1.2	V
Reference Input Resistance		R_{REF}	22.4	32	41.6	k Ω
Analog Input Resistance		R_{AIN}		100		M Ω

2. Ordering Information

Table 2-1. ATmega88

Speed (MHz)	Power Supply	ISP Flash	Ordering Code	Package	Operation Range
2-8	1.8V to 5.5V	8 KB	ATmega88V-15MT	PN	Automotive (−40°C to +85°C)
2-8	1.8V to 5.5V	8 KB	ATmega88V-15AT	MA	Automotive (−40°C to +85°C)

3. Package Information

Table 3-1. Package Types

Package Type	
PN	32-pad, 5 × 5 × 1.0 mm body, lead pitch 0.50 mm, Quad Flat No-Lead/Micro Lead Frame Package (QFN/MLF): E2/D2 3.1 ±0.1 mm
MA	MA, 32 - Lead, 7 × 7 mm Body Size, 1.0 mm Body Thickness 0.5 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

Figure 3-1. PN

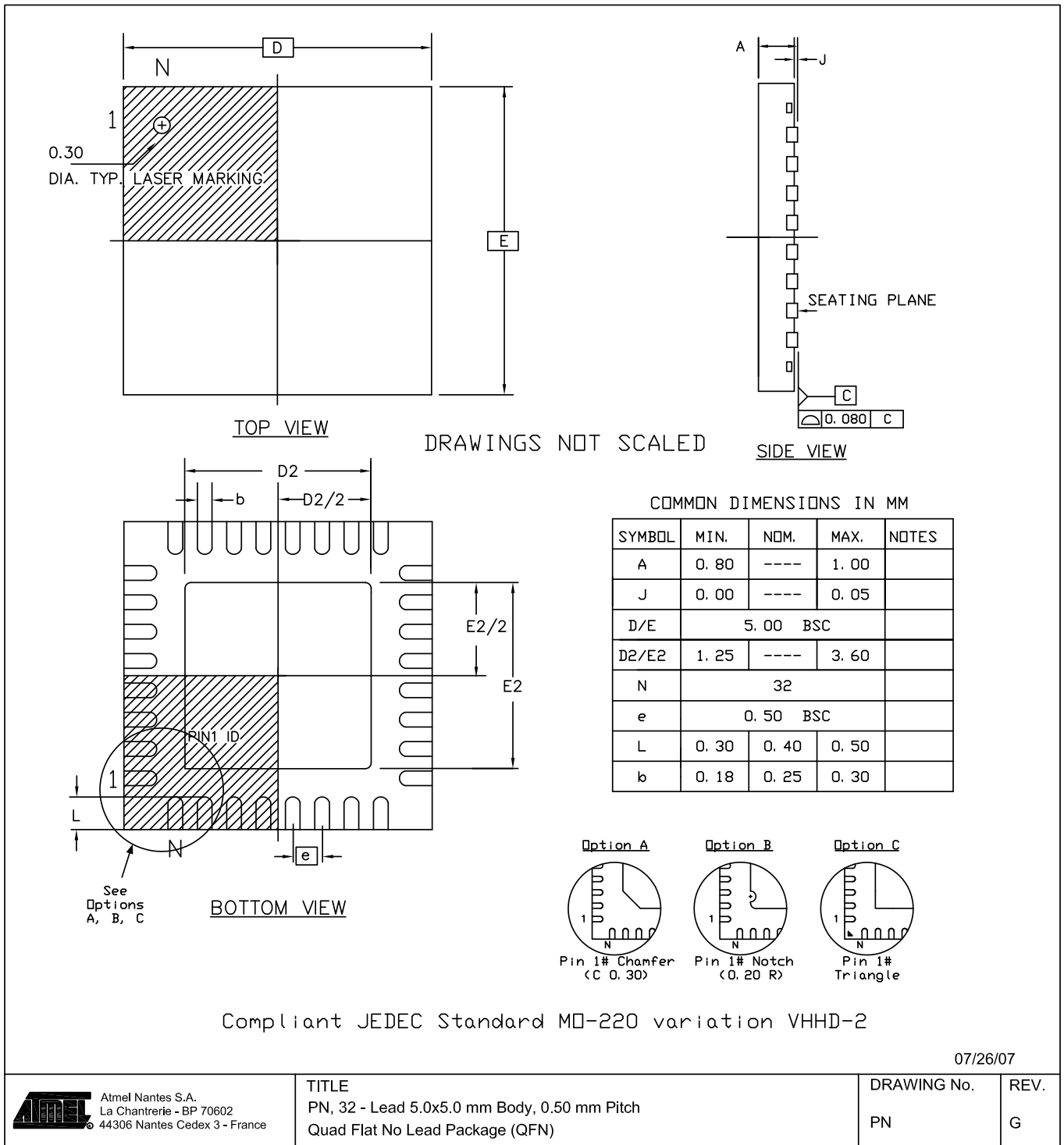
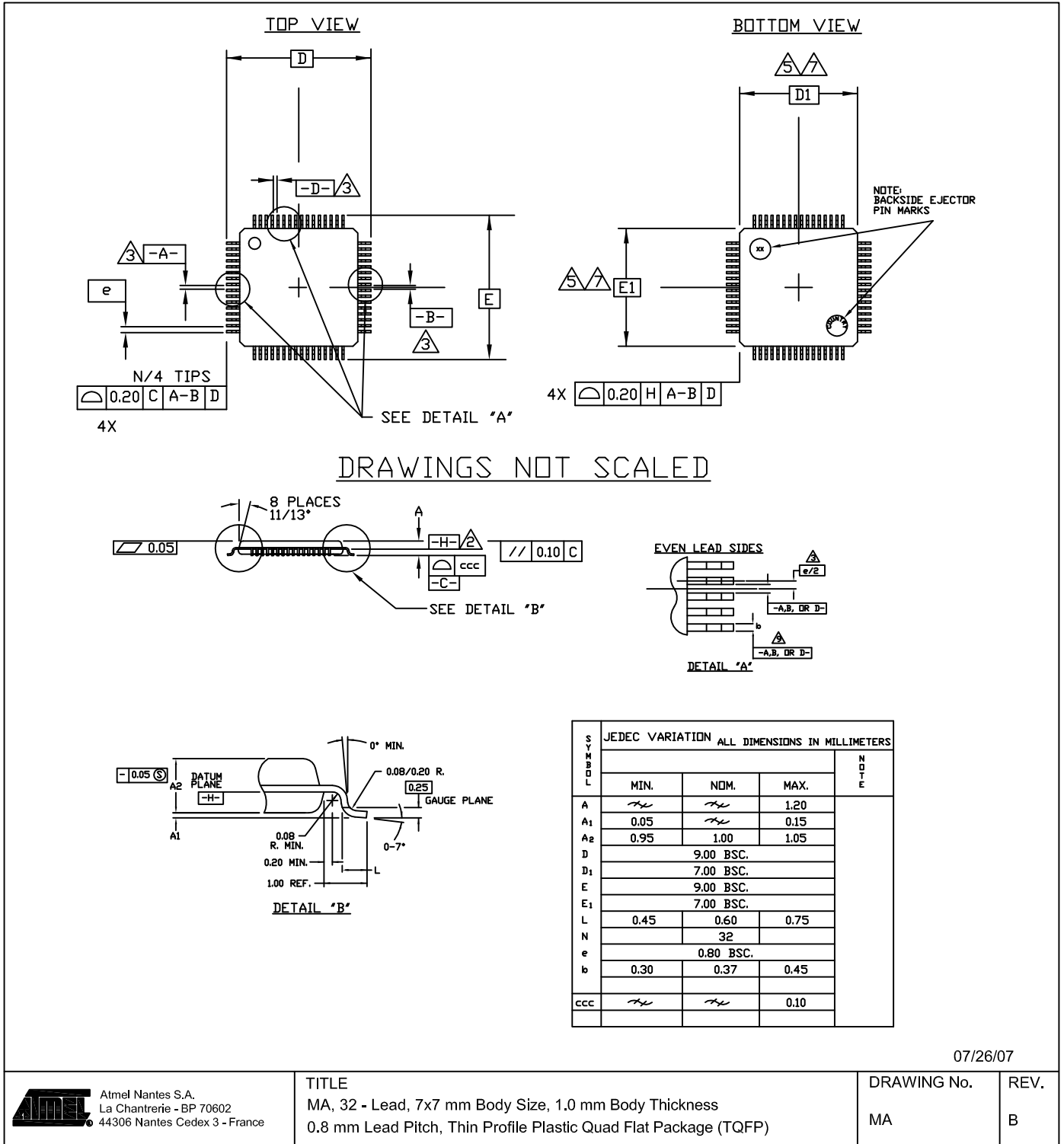


Figure 3-2. MA



07/26/07



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La Chantrerie - BP 70602
44306 Nantes Cedex 3 - France

TITLE
MA, 32 - Lead, 7x7 mm Body Size, 1.0 mm Body Thickness
0.8 mm Lead Pitch, Thin Profile Plastic Quad Flat Package (TQFP)

DRAWING No.

MA

REV.

B

4. Revision History

Please note that the following page numbers referred to in this section refer to the specific revision mentioned, not to this document.

Revision No.	History
7738C-AVR-11/09	<ul style="list-style-type: none">• ADC specification updates
7738B-AVR-07/09	<ul style="list-style-type: none">• Package MA updated
7738A-AVR-07/07	<ul style="list-style-type: none">• Document Creation



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